DOCUMENT RESUME

ED 436 406 SE 062 987

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TITLE Undergraduate Students in Science: What Do They Want To Be When They Grow Up?
PUB DATE 1999-11-17
NOTE 18p.; Paper presented at the Annual Meeting of the Mid-South Educational Research Association (Point Clear, AL, November 17-19, 1999).
PUB TYPE Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Females; Higher Education; Majors (Students); *Science Careers; *Science Interests; Scientists; Sociocultural Patterns; Student Attitudes; *Student Characteristics; Student Experience; *Student Interests; Student Motivation; Undergraduate Students

ABSTRACT

The purpose of this study is to examine a limited number of variables that have been documented in the literature as influential factors for women science majors and to determine which significantly influence undergraduate expectations to obtain science-related occupations. The results of this study indicate that several factors are worthy of attention, including some factors contradictory to those advocated in current literature. The findings contribute important information to the existing literature on factors predicting science occupation choice, especially in reference to undergraduate students in their first required science courses. The study also raises interest in the distinct possibility that there are significant changes that take place between post secondary and collegiate experiences. (Contains 11 references and 10 tables.) (WRM)

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Undergraduate Students in Science:
What do they want to be when they grow up?

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Abstract

Can it be determined what the predictors are for students entering and persisting in science-related occupations and if there are significant differences in gender and ethnicity? The purpose of this study is to examine a limited number of variables that have been documented in literature as influential factors for women science majors and determine which significantly influence undergraduate student expectations to obtain science-related occupations.

A survey was administered at a large southeastern research university during February 1999 to students enrolled in the first two required biology courses for majors in biology, microbiology, pre-health, and marine science. One hundred and eighty surveys were completed. Of that number, 169 were usable.

The dependent variable was whether or not the student expected to work in a science-related occupation. The independent variables included: course enrolled; gender; ethnicity; whether or not the guardians worked in science related occupations; the degree to which the student liked science; and whether the student believed science was important to everyone's life. Since the dependent variable and numerous independent variables were dichotomous in nature, logistic regression was the regression method chosen to conduct the analysis.

The final model generated by the backward logistic regression included the independent variables as predictors of the student entering a science-related occupation: whether the student liked science ($p<.001$); gender ($p<.05$); course ($p<.10$); and father's occupation ($p<.10$).

The results of this study indicate several factors worthy of attention including some factors contradictory to current literature. These all have implications for future research for educational practices. The findings contribute important information to the existing literature on factors predicting science occupation choice—especially in reference to undergraduate students in their first required science courses. It also raises interest in the possibility that there are significant changes that take place between post secondary and collegiate experiences.

Introduction

In 1972, Congress enacted Title IX which states: "No person in the United States shall, on the basis of sex, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any education program or activity receiving Federal financial assistance" (cited in Didion, 1997). Since its enactment, many areas of education have been effected by Title IX including women's participation in male-dominated disciplines such as science, mathematics, and engineering (Didion, 1997). Spurred by Title IX, numerous research studies have focused on factors that influence students, especially females and minorities, to become interested in science (for example, Hammrich, 1996), to major in science in college (for example, Seymour, 1995b), and to persist or drop out of science occupations (for example, Brennan, 1998). In October of 1998, Congress passed into law H.R. 3007, the Advancement of Women and Minorities in Science, Engineering, and Technology Act. With this law, a committee was established to study and report on barriers faced in science and engineering by women, minorities, and the disabled and to propose solutions (cited in White, 1998).

With this great concentration of time and resources spent on analyzing women and minorities in science, can it be determined what the predictors are for students entering and persisting in science-related occupations and if there are significant differences in gender and ethnicity? According to the literature, there are numerous variables that influence a student's selection for entering science, of which a few are briefly described here. Family background and parental expectations have been documented as factors that influence educational and occupational choices for women (Farmer, Anderson, & Brock, 1991; Rayman & Brett, 1995; Turner & Bowen, 1999). Once a student chooses a science major, however, gender has been shown to effect persistence rates in college (Strenta, Elliott, Matier, Scott, & Adair, 1993).

Although much less is known about post secondary experiences of women who select science, math, and engineering (SME) majors than secondary experiences, it has been documented that persistence rates of women in college are significantly lower than men (Seymour, 1995b). It has also been documented that the top reason science majors who switch majors to a non-science discipline did so due to a "lack or loss of interest in science" (Seymour, 1995a, p. 199).

Purpose of the Study

The purpose of this study, therefore, is to examine a limited number of variables that have been documented in literature as influential factors for women science majors and determine which significantly influence undergraduate student expectations during the first two required biology courses to obtain science-related occupations.

Description of the Data

A survey was administered during February 1999 at a large southeastern research university to students enrolled in Principles of Biology I (BSC 114), the first biology course required for science majors (specifically for biology, microbiology, marine science, and pre-health professional majors), and Principles of Biology II (BSC 116), the second course required for science majors. The chair of the Biology department stated that approximately 30% of students who take BSC 114 do not continue on to take BSC 116, and approximately 4% of declared majors change their major after taking these courses.

The survey consisted of 59 closed-end questions. Forty-seven questions were drawn from the Third International Mathematics and Science Study (TIMSS), a large international study of schools and students with data on half a million students from forty-one countries

(Third International Mathematics and Science Study, 1999). Although the TIMSS was administered only to elementary and secondary students, the questions were used in this survey so that future comparisons of the TIMSS and this analysis could be made.

The survey was distributed and collected during class time and only students in class and willing to participate the day the survey was administered are included in the sample. One hundred and eighty surveys were completed. Of that number, 169 were usable. The remaining surveys were disregarded due to missing data.

Description of the Variables

Each question on the survey was coded as a variable. Thus 59 possibilities for variables were available. For the purposes of this analysis, the dependent variable was the statement "Do you expect to work in a science-related occupation?" coded as [YOUOCCUP]. Students could respond by answering "yes" or "no," thus the dependent variable was dichotomous in nature. The independent variables included:

- ✓ Course enrolled, either BSC 114 or BSC 116, coded as [**COURSE**] (dichotomous variable, yes/no response)
- ✓ Gender, coded as [**GENDER**] (dichotomous variable, male/female)
- ✓ Ethnicity, with response options including African American, American Indian, Asian, Hispanic-Cuban-Puerto Rican, White-non Hispanic, Other and coded as [**ETHNICIT**]
- ✓ The statement "Does your mother or female guardian work in a science related occupation?" coded as [**MOOCCUP**] (dichotomous variable, yes/no response)
- ✓ The statement "Does your father or male guardian work in a science related occupation?" coded as [**FAOCCUP**] (dichotomous variable, yes/no response)

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- ✓ The statement "How much do you like science?" with response options of "a lot / some / not much / not at all," coded as [**LIKESCIE**]
- ✓ The statement "Do you think that biology is important to everyone's life?" coded as [**IMPORTAN**] (dichotomous variable, yes/no response)

Logistic Regression Analysis

Since the dependent variable and numerous independent variables were dichotomous in nature, logistic regression was the regression method chosen to conduct the analysis. The statistical software package, SPSS, version 8.0 for Windows, was used to generate the analysis. Using backward selection, the full model utilized all independent variables (course, gender, ethnicity, mother's occupation, father's occupation, whether the student liked science, and whether the student thought biology is important) to predict the dependent variable, the expectation of the student to enter a science-related occupation. The R^2 values for the full model include .312 according to the Cox & Snell procedure and .526 according to the Nagelkerke procedure (see Table 1). The significance level for removing a variable was .10. The variable relating to if the student thought biology is important was removed first, followed by mother's occupation, ethnicity, and father's occupation.

The final model generated by the backward logistic regression included independent variables course, gender, and whether the student liked science as predictors of the student entering a science-related occupation. The R^2 values for the final model include .292 according to the Cox & Snell procedure and .492 according to the Nagelkerke procedure (see Table 1). The resulting change in R^2 from the full to the final model is -.214 (Cox & Snell) and -.20 (Nagelkerke). Final regression coefficients are reported in Table 2.

TABLE 1: R Squared Values (Final Model)

MODEL	*Cox & Snell* R^2	*Nagelkerke* R^2
Full Model	.312	.526
Final Model	.292	.492

TABLE 2: Regression Coefficients (Final Model)

Variable	*B*	*Significance*
Course	-1.3769	.0147
Gender	1.1142	.0572
Like Science	1.8241	.0000
Constant (Student's Occupation)	-4.9041	.0009

To detect outliers, studentized residuals were reviewed and cases with values greater than 2.0 were removed. In doing so, four cases were removed from the original raw data. Backward logistic regression analysis was run after the removal of the outliers. Multicollinearity was checked by reviewing correlations between independent variables. With the highest correlation less than .40 (R = -.39), multicollinearity was not considered to be a problem. Using backward selection, the full model utilized all independent variables (course, gender, ethnicity, mother's occupation, father's occupation, whether the student liked science, and whether the student thought biology is important) to predict the dependent variable, the expectation of the student to enter a science-related occupation. The R^2 values for the full model include .363 according to the Cox & Snell procedure and .634 according to the Nagelkerke procedure (see Table 3). The significance level for removing a variable was .10. Mother's occupation was the variable removed first, followed by ethnicity, and whether the student felt biology was important.

The final model generated by the backward logistic regression included independent variables **course**, **gender**, **father's occupation**, and **whether the student liked science** as predictors of the student entering a science-related occupation. The R^2 values for the final

model include .358 according to the Cox & Snell procedure and .624 according to the Nagelkerke procedure (see Table 3). The resulting change in R^2 from the full to the final model is -.005 (Cox & Snell) and -.01 (Nagelkerke). Final regression coefficients are reported in Table 4, and descriptives and frequency tables are included in the appendix.

TABLE 3: R^2 Values (after removal of outliers)

MODEL	*Cox & Snell* R^2	*Nagelkerke* R^2
Full Model	.363	.634
Final Model	.358	.624

TABLE 4: Regression Coefficients (Final Model after removal of outliers)

Variable	*B*	*Significance*
Course	-1.1548	.0794
Gender	1.6778	.0267
Father's Occupation	2.0042	.0816
Like Science	2.3944	.0000
Constant (Student's Occupation)	-4.9041	.0009

As evidenced in the classification table (Table 5), overall approximately 90% of the participants were predicted correctly. The independent/covariate variables in the final model were better at helping to predict who did expect to obtain a science-related occupation (approximately 97% correct) than those who did not (approximately 52% correct).

TABLE 5: Classification Table

	Predicted		
Observed	*Expect to work in science occupation*	*Did not expect to work in science occupation*	*Percent Correct*
Expect to work in science occupation	136	4	97.14%
Did not expect to work in science occupation	12	13	52.00%
		Overall	**90.30%**

Conclusion

Procedure Summary

Using data generated from a survey administered to undergraduate students enrolled in the first two courses required for biology majors, a backward logistic regression was generated to determine variables that could significantly predict if students expected to work in a science-related occupation. The initial model included variables course, gender, ethnicity, mother's occupation, father's occupation, how much the student liked science, and if they thought science was important to everyone's life. The final model included three independent variables (course, gender, like science) as significant predictors of the student's expectation to enter a science occupation. In analyzing studentized residuals, however, four outlying cases were detected and removed from the raw data.

Backward logistic regression was again performed after the removal of outliers. Upon this run of the data, the final model included four independent variables (course, gender, father's occupation, and like science) as significant predictors of the student's expectation to enter a science-related occupation. In reviewing the analysis of the regression after outliers were removed, not only were there differences in the number and selection of independent variables, but the R^2 values were also higher in this analysis.

Recommendations

The final model recommended includes course, gender, father's occupation, and whether a student likes science as predictors of whether the student will enter a science-related occupation. The results of this study indicate several factors worthy of attention including some factors contradictory to current literature. These all have implications for future research for educational practices. This discussion will begin by looking at the factors

included in the final model that indicate by statistical significance that they do make a difference in student expectations of choosing a science-related occupation.

Like Science

How much a student liked science was the most significant variable in the final model ($p < .001$). Over 50% liked science a lot, 32.1% some, 8.5% not much, and 5.5% not at all (see frequency appendix). Interest and enjoyment in science, however, are a result of many additional factors such as teaching method and exposure to science. Therefore additional research into how the student's interest in science was formed would provide important supplemental information to this variable.

Gender

Following liking science, gender was the next most significant predictor ($p < .05$). As presented previously in this study, this has been documented and proven numerous times and is further supported in this study. It is also important that there was nearly a 50/50 split on participants in relation to this variable. Males constituted 47.3% of participants and females 52.7%.

Course

The next most significant predictor ($p < .10$) was the course the student was enrolled in. Although the chair of the biology department did indicate that a substantial number of students who enrolled in the first course (BSC 114) do not return for the second course (BSC 116), it is also disheartening to think that students are basing their expectation of obtaining a science-related occupation as a result of one class. This has important

implications in teaching practices and mentoring beginning students as the first course can be considered somewhat of a make-or-break course for science majors. Approximately 34% of participants were enrolled in the first course and 66% enrolled in the second course.

Father's Occupation

The last significant predictor to the model was father's occupation ($p < .10$). Although literature has shown that having parents in science occupations is not a significant predictor for science persistence after graduation, it has been shown that it is an important factor for women in choice of major and selecting science as a major (Rayman & Brett, 1995). It is interesting and important to note that in this study, only the father had a significant effect, contradicting to some extent, other studies. Of participants in this study, 23% had fathers employed in science-related occupations.

Non-Significant Variables

It is also important to review those variables that did not contribute significantly to the final model. These variables and resulting discussion are included as follows.

Mother's Occupation

Mother's occupation was the first variable removed from the model indicating that it was the least significant predictor of all non-significant contributors. This was an unexpected result considering literature that suggests whether the mother is in a science occupation does influence the child's career choice as well as the significance that father's occupation had in the final model. There were nearly as many students who had mothers in science occupations as those who had fathers: 21.8%.

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Ethnicity

Another surprising result from this study was that ethnicity was not a significant contributor to a student's expectation of entering a science related occupation (approximately 22% of participants were minorities). This is in great contrast to numerous studies and is an extremely important factor for future research. Numerous research has concentrated on differences between the majority (white non-Hispanics) and minorities in relation to selecting science as a major and as a career. Is it possible that a student's ethnic background is becoming less important in career selection and measures that have been put in place to remove barriers to minorities are working?

Felt Biology was Important

Whether a student felt biology was important to everyone's life was the last variable removed as non-significant to the model. Although this factor was not found specifically addressed in literature or previous studies, it was expected that those students who felt biology was important would also be more likely to select a science-related occupation. Although this study indicates its non-significance, it is important to note that it was the last variable removed— and thus though non-significant, it was more significant as a predictor of choosing a science-related occupation than both mother's occupation and ethnicity. (As noted in the frequency appendix, nearly 81% felt biology was important to everyone's life.)

Conclusion

The findings from this study contribute important information to the existing literature on factors predicting science occupation choice— especially in reference to undergraduate students in their first required science courses. It also raises interest in the possibility that there are significant changes that take place between secondary and collegiate experiences.

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Frequencies

Statistics

		course enrolled	gender	ethnicity	mother's occupation	father's occupation	student's expectation to work in science related occupation
N	Valid	165	165	165	165	165	165
	Missing	0	0	0	0	0	0

Statistics

		How much do you like science?	Do you think biology is important to everyone's life?
N	Valid	165	165
	Missing	0	0

Frequency Table

course enrolled

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BSC 114	56	33.9	33.9	33.9
	BSC 116	109	66.1	66.1	100.0
	Total	165	100.0	100.0	

gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	male	78	47.3	47.3	47.3
	female	87	52.7	52.7	100.0
	Total	165	100.0	100.0	

ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	.6	.6	.6
	African American	30	18.2	18.2	18.8
	Asian	4	2.4	2.4	21.2
	White, non-Hispanic	128	77.6	77.6	98.8
	Other	2	1.2	1.2	100.0
	Total	165	100.0	100.0	

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mother's occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	.6	.6	.6
	mother works in science related occupation	36	21.8	21.8	22.4
	mother does not work in science related occupation	128	77.6	77.6	100.0
	Total	165	100.0	100.0	

father's occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	.00	1	.6	.6	.6
	father works in science related occupation	38	23.0	23.0	23.6
	father does not work in science related occupation	126	76.4	76.4	100.0
	Total	165	100.0	100.0	

student's expectation to work in science related occupation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	expects to work in science related occupation	140	84.8	84.8	84.8
	does not expect to work in science related occupation	25	15.2	15.2	100.0
	Total	165	100.0	100.0	

How much do you like science?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A lot	89	53.9	53.9	53.9
	Some	53	32.1	32.1	86.1
	Not much	14	8.5	8.5	94.5
	Not at all	9	5.5	5.5	100.0
	Total	165	100.0	100.0	

Do you think biology is important to everyone's life?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	133	80.6	80.6	80.6
	no	32	19.4	19.4	100.0
	Total	165	100.0	100.0	